In the Claims

Please amend the claims as follows:

1. (Currently Amended) An optical element operable to compensate for dispersion associated with a transmission link, the optical element comprising: ~~In a fiber-optic transmission system including at least one transmission link having a length, optical loss, dispersion, a sign of dispersion and a cut-off wavelength, the invention comprising a single and an optical element to compensate for the dispersion and to balance the optical loss, the optical element including:~~

an input port operable to receive ~~for receiving~~ an optical signal from at least one transmission link, the optical signal comprising ~~having a signal~~ an optical signal wavelength, the at least one transmission link having a length, an optical loss, a dispersion, a sign of dispersion, and a cut-off wavelength;

a distributed Raman gain medium having an optical loss and connected to the input port, the distributed Raman gain medium operable to amplify the optical signal and to compensate for dispersion associated with the at least one transmission link, wherein the distributed Raman gain medium comprises a dispersion-length product that is substantially equal in magnitude to a dispersion-length product of the at least one transmission link and wherein the distributed Raman gain medium comprises a sign of dispersion that is opposite a sign of dispersion associated with the at least one transmission link;

~~a pumping mechanism having a pump wavelength for generating a pumping light to pump the distributed gain medium at a pumping level sufficiently high so that the optical signal experiences a net gain to compensate for the optical losses of the transmission link and the gain medium; and~~

a pump source configured to be coupled to the distributed Raman gain medium, the pump source operable to generate a pump signal to pump the distributed Raman gain medium to compensate for the optical loss of the transmission link and the optical loss of the distributed Raman gain medium, wherein the pump source generates the pump signal at a pumping level sufficiently high so that the optical signal experiences a net gain; and

an output port for outputting the amplified optical signal.

2. (Currently Amended) ~~The invention as claimed in claim 1,~~ The optical element of Claim 1, wherein the distributed gain ~~medium is gain~~ fiber ~~having~~ comprises a length, dispersion and a sign of dispersion.

3. (Currently Amended) ~~The invention as claimed in claim 2~~ The optical element of Claim 2, wherein the gain fiber has a dispersion-length product substantially equal in magnitude to a dispersion-length product ~~20 product~~ of the at least one transmission link but of opposite sign.

4. (Currently Amended) ~~The invention as claimed in claim 2~~ The optical element of Claim 2, wherein the gain fiber has a cut-off wavelength shorter than the pump wavelength so that the gain fiber is single spatial mode for both the pump wavelength and the signal wavelength.

5. (Currently Amended) ~~The invention as claimed in claim 2~~ The optical element of Claim 2, wherein the optical signal is amplified in open loop fashion.

6. (Currently Amended) ~~The invention as claimed in claim 5~~ The optical element of Claim 5, wherein the gain fiber is pumped bi-directionally by the pumping mechanism.

7. (Currently Amended) ~~The invention as claimed in claim 5~~ The optical element of Claim 5, wherein the gain fiber has two separate segments and wherein the ~~pumping mechanism~~ pump source pumps the two segments in a counter-propagating fashion.

8. (Currently Amended) ~~The invention as claimed in claim 7~~ The optical element of Claim 7, further comprising an isolator to connect the two segments.

9. (Currently Amended) ~~The invention as claimed in claim 7~~ The optical element of Claim 7, further comprising a gain equalization element to connect the two segments.

10. (Currently Amended) ~~The invention as claimed in claim 7~~ The optical element of Claim 7, further comprising an optical add/drop multiplexer to connect the two segments.

11. (Currently Amended) ~~The invention as claimed in claim 10~~ The optical element of Claim 10, further comprising a gain equalization element connected to the optical add/drop multiplexer.

12. (Currently Amended) In a fiber-optic transmission system, the system comprising: ~~including at least one transmission link having a length, optical loss, dispersion, a sign of dispersion and a cut-off wavelength, the invention comprising:~~

~~an input~~ a signal input port operable to receive ~~for receiving~~ an optical signal from at least one transmission line, the optical signal comprising one or more signal wavelengths, ~~having a signal wavelength~~ the at least one transmission line having a length, an optical loss, a dispersion, a sign of dispersion, and a cut-off wavelength;

a Raman gain fiber coupled to the signal input port and operable to amplify the optical signal, the Raman gain fiber having an optical loss and comprising a first Raman gain segment and a second Raman gain segment, wherein the optical signal traverses the Raman gain fiber in a first direction; ~~and connected to the input port to amplify the optical signal;~~

~~a pumping mechanism having a pump wavelength for generating a pumping light to pump the gain fiber at a pumping level sufficiently high so that the optical signal experiences a net gain to compensate for the optical losses of the transmission link and the gain fiber;~~

a pump source configured to be coupled to the Raman gain fiber, the pump source operable to generate a pump signal to pump the Raman gain fiber to compensate for the optical loss of the transmission link and the optical loss of the Raman gain fiber, the pump signal comprising a pump wavelength and a pump power, wherein the pump source produces the pump signal at a pumping level sufficiently high so that the optical signal experiences a net gain;

~~an output~~ a signal output port for outputting the ~~amplified~~ optical signal; and

a pump shunt coupled to the signal input port and the signal output port, ~~ports to shunt the pumping mechanism wherein the gain fiber has separate first and second segments separated by the input and output ports and wherein the pumping mechanism pumps the first segment in a counter-propagating fashion~~ the pump shunt operable to couple at least a portion of the pump signal between the first Raman gain segment and the second Raman gain segment, wherein the first Raman gain segment is coupled to the signal input port and the second Raman gain segment is coupled to the signal output port and wherein the pump signal traverses the first Raman gain segment in a direction counter to the first direction and then traverses ~~pumps~~ the second segment to deplete the pump power of the pump signal. ~~pumping mechanism.~~

13. (Currently Amended) ~~The invention as claimed in claim 12~~ The system of Claim 12, further comprising an isolator to connect the first and second Raman gain segments.

14. (Currently Amended) ~~The invention as claimed in claim 12~~ The system of Claim 12, further comprising a gain equalization element to connect the first and second Raman gain segments.

15. (Currently Amended) ~~The invention as claimed in claim 12~~ The system of Claim 12, further comprising an optical add/drop multiplexer to connect the first and second Raman gain segments.

16. (Currently Amended) ~~The invention as claimed in claim 12~~ The system of Claim 12, wherein the second Raman gain segment is pumped bi-directionally by the pump source ~~pumping mechanism~~.

17. (Currently Amended) ~~The invention as claimed in claim 2~~ The optical element of Claim 2, wherein the optical signal is amplified in a closed loop fashion.

18. (Currently Amended) ~~The invention as claimed in claim 2~~ The optical element of Claim 2, wherein the gain fiber at least partially defines a broadband cavity which is pumped bi-directionally by the pumping mechanism.

19. (Currently Amended) ~~The invention as claimed in claim 18~~ The optical element of Claim 18, wherein the gain fiber is a Raman gain fiber and wherein the broadband cavity is a Sagnac Raman cavity.

20. (Currently Amended) ~~The invention as claimed in claim 2~~ The optical element of Claim 2, wherein the distributed gain medium includes a circular loop cavity and wherein the gain fiber has two separate segments which are pumped in a counter-propagating fashion by the pumping mechanism.

21. (Currently Amended) ~~The invention as claimed in claim 1~~ The optical element of Claim 1, wherein the transmission line is a multi-wavelength transmission line having non-uniform gain over different wavelength channels and further comprising a second optical element for evening the non-uniform gain over the different wavelength channels.

22. (Currently Amended) ~~The invention as claimed in claim 21~~ The optical element of Claim 21, wherein the second optical element includes at least one stage of Mach-Zehnder interferometers.

23. (Currently Amended) ~~The invention as claimed in claim 21~~ The optical element of Claim 21, wherein the distributed gain mechanism is a gain fiber having two separate segments and wherein the second optical element connects the two segments.

24. (Currently Amended) A fiber-optic transmission system, the fiber-optic transmission system comprising: ~~In a fiber-optic transmission system which operates in a violet band between 1430 and 1530 nm and includes at least one transmission link having a length, optical loss, dispersion, a sign of dispersion and a cut-off wavelength and a dispersion shifted fiber (DSF) having at least one fiber non-linearity effect and a zero dispersion wavelength, the invention comprising:~~

at least one transmission link operable to communicate one or more optical signals in a violet communication band, the at least one transmission link having a length, an optical loss, a dispersion, a sign of dispersion, and a cut-off wavelength, wherein the at least one transmission link comprises a dispersion shifted fiber (DSF) having at least one fiber non-linearity effect and a zero dispersion wavelength; and

an optical element operable to receive the one or more optical signals in the violet communication band and to amplify the one or more optical signals, the optical element comprising:

an input port operable to receive the one or more optical signals from the at least one transmission link, the optical signal comprising a signal wavelength;

a distributed Raman gain medium coupled to the input port and operable to amplify the one or more optical signals, the distributed Raman gain medium having an optical loss, wherein the optical element operates to compensate for the optical loss of the transmission link and the optical loss of the distributed Raman gain medium;

a pump source operable to generate a pump light to pump the distributed Raman gain medium at a pumping level sufficiently high so that the one or more optical signals experience a net gain in the violet communication band, wherein the net gain experienced in the violet communication band is sufficiently far from the zero dispersion wavelength of the at least one transmission link to avoid the at least one fiber non-linearity effect in the at least one transmission link; and

an output port for outputting the amplified one or more optical signals.

~~an input port for receiving an optical signal having a signal wavelength;~~

~~a distributed gain medium having an optical loss and connected to the input port to amplify the optical signal;~~

~~a pumping mechanism having a pump wavelength for generating a pumping light to pump the distributed gain medium at a pumping level sufficiently high so that the optical signal experiences a net gain in the violet band to compensate for the optical losses of the~~

~~transmission link and the gain medium and sufficiently far from the zero dispersion wavelength to avoid the at least one fiber non-linearity effect in the at least one link; and~~

~~an output port for outputting the amplified optical signal.~~

25. (Currently Amended) ~~The invention as claimed in claim 24~~ The system of Claim 24, wherein the gain medium ~~fiber~~ is a standard dispersion fiber.

26. (Currently Amended) ~~The invention as claimed in claim 24~~ The system of Claim 24, wherein the at least one fiber non-linearity is four-wave mixing.

27. (Currently Amended) ~~The invention as claimed in claim 24~~ The system of Claim 24, wherein the at least one fiber non-linearity is modulation instability.

28. (Currently Amended) ~~The invention as claimed in claim 24~~ The system of Claim 24, wherein the DSF has a plurality of fiber non-linearities including four-wave mixing and modulation instability and wherein the ~~single~~ optical element avoids the plurality of fiber nonlinearities.

29. (Currently Amended) ~~The invention as claimed in claim 24~~ The system of Claim 24, wherein the at least one transmission link has non-uniform gain over different wavelength channels and further comprising a second optical element ~~connected~~ coupled to the ~~single~~ optical element for evening the non-uniform gain over the different wavelength channels.

30. (Currently Amended) ~~The invention as claimed in claim 29~~ The system of Claim 29, wherein the second optical element includes at least one stage of Mach-Zehnder interferometers.

31. (Currently Amended) ~~The invention as claimed in claim 24~~ The system of Claim 24, wherein the gain medium comprises ~~fiber is~~ a dispersion compensating fiber and wherein the dispersion compensating fiber is selected so that accumulated dispersion is balanced at a substantial middle of the violet band.

32. (Withdrawn) In a fiber-optic multi-band system including a multi-wavelength transmission line, a method for minimizing gain tilt within at least one existing band of wavelengths as additional bands of wavelengths are added, the method comprising:

adding a substantially equal number of additional bands both above and below the at least one existing band of wavelengths to obtain shorter and longer wavelength bands to minimize energy change in the at least one existing band of wavelengths; and

amplifying the shorter and longer wavelength bands so that each of the shorter and longer wavelength bands has a gain.

33. (Withdrawn) The method as claimed in claim 32 wherein the step of amplifying the shorter wavelength bands is accomplished with discrete or distributed Raman amplifiers.

34. (Withdrawn) The method as claimed in claim 32 wherein the step of amplifying the longer wavelength bands is accomplished with Erbium-doped fiber amplifiers wherein the gain in at least one of the shorter wavelength bands is greater than the gain in at least one of the longer wavelength bands.

35. (Withdrawn) The method as claimed in claim 32 wherein the gain in at least one of the shorter wavelength bands is greater than the gain in at least one of the longer wavelength bands.

36. (Withdrawn) The method as claimed in claim 32 wherein the step of amplifying the shorter wavelength bands is done in a distributed fashion.

37. (Withdrawn) In a fiber-optic multi-band transmission system including a multi-wave transmission line, the apparatus comprising:

a plurality of band pumps for pumping different bands of the transmission line to obtain amplification wherein band pumps for different bands interact non-linearly by exchanging energy; and

means for orthogonalizing adjacent band pumps to minimize the nonlinear interaction.

38. (Withdrawn) The apparatus as claimed in claim 37 wherein alternate band pumps are spatially dispersed to minimize interaction between band pumps for the different bands.

39. (Withdrawn) The apparatus as claimed in claim 37 wherein alternate band pumps are cross-polarized to minimize interaction between band pumps for the different bands.

40. (Withdrawn) The apparatus as claimed in claim 37 wherein the plurality of band pumps define a purely distributed system of distributed Raman amplifiers.

41. (Withdrawn) The apparatus as claimed in claim 37 wherein the plurality of band pumps define a hybrid system of discrete and distributed amplifiers.

42. (Withdrawn) The apparatus as claimed in claim 37 wherein the plurality of band pumps include discrete laser diodes for pumping the transmission line.

43. (Withdrawn) The apparatus as claimed in claim 37 wherein the plurality of band pumps include a Raman oscillator for pumping the transmission line.

44. (Currently Amended) ~~The invention as claimed in claim 1~~ The optical element of Claim 1, wherein the ~~pumping mechanism~~ pump source includes at least one laser diode.

45. (Currently Amended) ~~The invention as claimed in claim 1~~ The optical element of Claim 1, wherein the ~~pumping mechanism~~ pump source includes a Raman oscillator.

46. (Currently Amended) ~~The invention as claimed in claim 1~~ The optical element of Claim 1, wherein the ~~pumping mechanism~~ pump source includes a Raman wavelength shifter.

47. (Currently Amended) ~~The invention as claimed in claim 2~~ The optical element of Claim 2, wherein the gain fiber exhibits Raman scattering when pumped by the ~~pumping mechanism~~ pump source.

48. (Currently Amended) ~~The invention as claimed in claim 20~~ The optical element of Claim 20, wherein the distributed gain medium includes chirped bragg gratings.

49. (Withdrawn) The invention as claimed in claim 37 wherein the amplification is distributed Raman amplification and wherein the energy is Raman energy.

50. (Currently Amended) ~~The invention as claimed in claim 24~~ The system of Claim 24, wherein the distributed gain medium utilizes Raman gain.

51. (New) The optical element of Claim 1, wherein the magnitude of the dispersion-length product of the distributed Raman gain medium is within ten percent (10%) of the magnitude of the dispersion-length product of the at least one transmission link.

52. (New) The system of Claim 24, wherein the net gain experienced in the violet communication band is at least twenty (20) nanometers from the zero dispersion wavelength of the at least one transmission link.